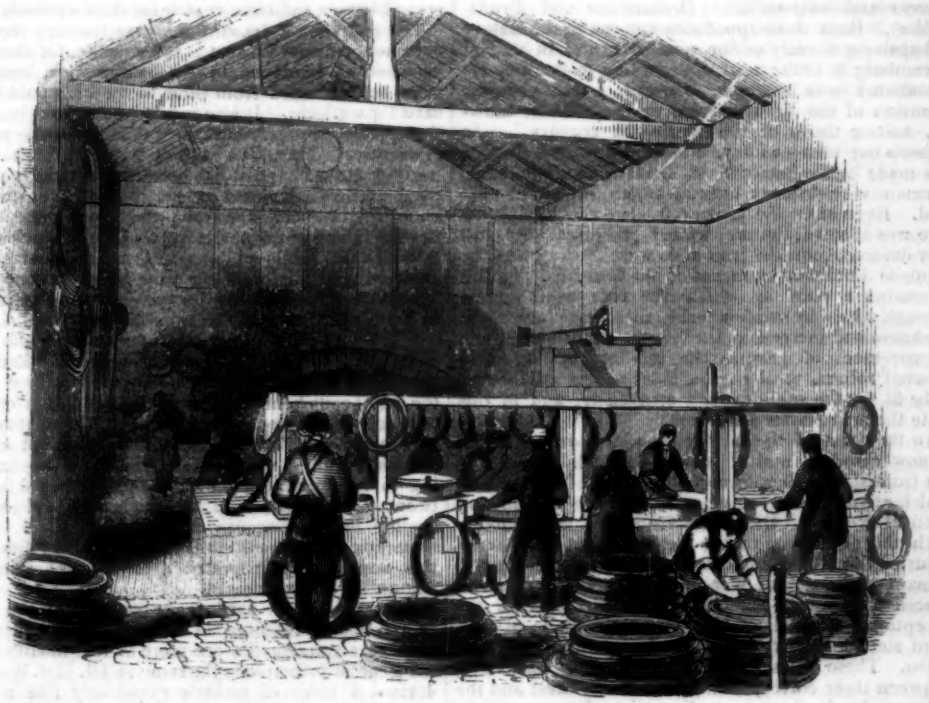
# A SECOND DAY AT THE BIRMINGHAM FACTORIES.



[Wire-drawing Machines.—Birmingham Wire-Works.]

In the last Supplement we had occasion to speak of several branches of Birmingham manufacture in which brass or copper, or some alloy intermediate between the two, is the material on which the skill of the operator is displayed. There are many more such, differing only in minor details of working from these; but we may pass over them, and say a few words on other matters.

## *Wire.*

Wire-drawing, or the manufacture of wire from rods of iron, steel, or other metal, is extensively carried on at Birmingham, and is a process illustrating in a remarkable degree the ductility of metals. Unless a person has actually witnessed the operations, there is some difficulty in conceiving how the transformation takes place—how the diameter of the rod lessens and the length increases. There is no hammering or pressing or stamping, no cutting or dividing, no moulding or casting; and perhaps this is almost the only operation in the mechanical arts in which alteration of shape is produced without any one of the above agencies.

At the Wire-Works of Messrs. Carpenter and Co., to which we were favoured with access, the outline of the arrangements is such as may be here briefly described. The factory is situated in the western part of Birmingham, and consists of several buildings, of which some are occupied by wire-drawers, and the rest in a way afterwards to be noticed. There is considerable power required in the transformation of the iron rods into wire, and to provide this force there is a steam-engine employed. The other apparatus will come for notice as we proceed.

As nearly all wire is made pretty much in the same manner, it will suffice to confine our attention to that made of iron. The iron is brought to the Works in coils of rods, wrought to the state of what may perhaps be termed thick wire. In the Supplement for February, while describing the operations at a large Iron-Work, we explained how iron is brought into the form of rods and bars, by being drawn between two heavy revolving rollers while in a white-hot state. For wire-work this drawing is conducted to a greater extent than for most other purposes, until the lengthened rod is thin enough to be twisted up into a coil, and in that state to be transferred to the wire-factories.

The iron is covered with scale (the hard oxide produced by the heat necessary to roll the rods) when it comes to the Works; and to remove this scale the coils are put into large revolving cylinders containing gravel and water, the friction against which effects the desired object. From these vessels the coils are taken to a large shop or room where the whole apparatus is contained for reducing the thickness of the metal. Previously to describing these, it may be well to notice the successive steps whereby the present system has been brought about.

Narrow filaments of metal have probably been employed for various purposes from very early times; but Beckmann supposes that, in the first instance, the metal was beaten with a hammer into thin plates or leaves, that these leaves were afterwards divided into

small slips by a pair of shears or some similar instrument, and that the slips were hammered and filed to a tolerably round form. Respecting the subsequent change in the mode of operation Beckmann says, "As long as the work was prepared by the hammer, the artists at Nuremberg were called *wire-smiths*; but after the invention of the drawing-iron they were called *wire-drawers* and *wire-millers* (*Drahtzieher* and *Drahtmühler*). Both these appellations occur in the history of Augsburg so early as the year 1351, and in that of Nuremberg in 1369; so that, according to the best information I have been able to obtain, I must class the invention of the drawing-iron, or proper wire-drawing, among those of the fourteenth century." As respects our own country, it is supposed that all wire was made by the hammer till about 1565, when some German wire-drawers introduced an improved method. Even after the improved plan of drawing the wire was adopted, the preparatory processes were still very defective, for the iron rods were brought to the requisite thickness by means of the hammer. To this succeeded a plan by which the rods were drawn through a hole by sudden jerks, thereby reducing the thickness and increasing the length. Lastly came the improvement of passing the red-hot rods between grooved rollers, until such a thickness is attained as to be fit for the wire-drawer's operations; and in this state the art remains at present.

In the room of the factory to which our attention is now directed, and of which a sketch is given in the frontispiece, there is a double range of benches, on which are a number of wheels or drums rotating on vertical axes. All these axes are placed in connexion with the machinery of the steam-engine, and are so adjusted that the drums may be made to rotate or to remain stationary at pleasure. Near each drum is placed a 'drawing-plate,' pierced with holes for the reception of the wire. The plates are made of very hard steel, and have holes punched carefully through them. These holes have all intermediate diameters, between those corresponding with the thickest and the thinnest kinds of wire; and, as the plates are easily removed from the stand in which they rest, there are the means for employing draw-plates of any required kind.

The principle of wire-drawing consists in forcing the rod of metal to pass through a hole rather smaller than itself. This could not be done unless the metal possessed a yielding quality, for a portion of the diameter must be squeezed out of its place, and made to elongate the piece. The draw-plates, then, have the holes through which the metal is to be forced, and the drums give the necessary drawing-power. One end of a coil of wire is hammered or filed thinner, and inserted into one of the holes of a draw-plate, and after being pulled through it is held tight by an instrument attached to the drum; the drum is made to rotate rapidly, and in so doing draws the metal through the hole, and causes it to wind round the drum itself, the diameter of the wire being a little decreased by this agency. It is then passed similarly through a second hole somewhat smaller than the first, by exactly similar means, whereby a second stage of attenuation is brought about. Step by step does this continue, different draw-plates and different drums being employed, until the iron is brought to any required degree of fineness. It is by very small degrees that these changes are produced; for if an attempt were made to draw the wire through a hole much smaller than itself, it would break. There is a gauge employed, to determine the size of the wire; and the size so determined is indicated by numbers: for instance, wire No. 1 is about three-tenths of an inch in diameter, while No. 26 is not above one-fiftieth of an inch. There is, however, some little diversity in this matter in different factories, even to the extent of beginning with No. 1 at the smallest diameter, and going upwards to the largest. It would seem as if some designation which would give the actual diameter, such as the number of hundredths of an inch, would remove all ambiguity; but doubtless those concerned have a sufficient reason for their systems.

The mere act of drawing the wire through the holes does not comprise all that is to be done; for the metal becomes so hardened by the compression, that if it were not annealed from time to time it would be too hard for working. It also requires to be roughened by the application of sulphuric acid to facilitate the process of drawing. There is a kind of iron called 'charcoal'-iron (in which charcoal has been used instead of coal in the smelting) calculated to bear more drawing without annealing than common iron; and the number of annealings therefore depends partly on the thickness of the wire and partly on the quality of the metal. The arrangements for annealing are curious: in one of the buildings of the factory are annealing-kilns, cylindrical in form, three or four feet in diameter, and eight or ten in depth; they are made of iron, encased externally with brick. The coils of wire, as taken from the drums, are laid flat one on another in these kilns; the small coils being placed within the larger ones, so as to lose as little space as possible. After every aperture is closed, a fire is kindled, and the hot air circulates round the vessel, keeping the wire—amounting to twenty or thirty cwt. at once—at a red heat for twenty-four hours; or rather, the heating and the slow cooling together occupy this space of time. In the reduction of the metal to the state of very fine wire, this annealing is repeated several times, sometimes amounting to six or eight.

According to the hardness or softness of the metal, or the tenuity required to be attained, some or other of these arrangements are more or less modified; but the general principle is the same in all. Dr. Wollaston devised a mode of making exquisitely fine wire for micrometrical purposes by the following ingenious contrivance: he made some platinum wire, so small as 1-300th of an inch diameter, by a draw-plate of his own invention; then made a tiny cylinder or mould, down the centre of which he placed the wire; then poured melted silver into this mould, so as to form a sort of little ingot enveloping the platinum; then drew this ingot into the state of a wire nearly or quite as fine as the platinum had been; then immersed the wire thus produced into hot nitric acid, by which all the silver was dissolved, leaving a central fibre of platinum smaller perhaps than human *eye* had ever before (or since) seen: so fine, indeed, that in some instances he produced platinum wire less than one ten-thousandth part of an inch in diameter! For some fine and delicate purposes, in which the wearing away of the draw-holes would be a detriment, it was proposed some years ago to use diamonds, sapphires, or rubies as the material for draw-plates, on account of their excessive hardness; but this costly project is somewhat too startling for manufacturers in general.

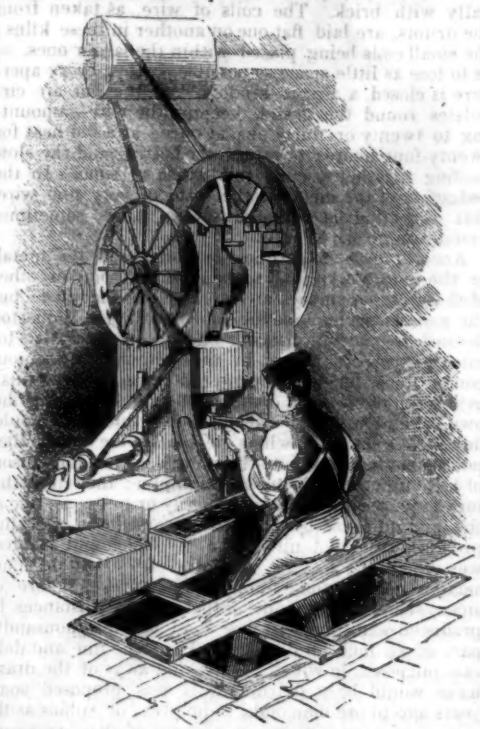
### *Screws.*

The same factory which has here engaged our attention also furnishes the means for observing the *Screw-manufacture*, an extensive department of Birmingham industry.

A screw is, as most persons may surmise, a piece of wire (generally iron), with certain appliances at its two ends to make it serve a particular purpose. The thread or worm twisted round it prevents it from being driven into wood so readily as a nail, but, on the other hand, it retains its hold more firmly on account of the circu-

lar motion necessary for its extraction. The head of the screw answers much the same purpose as that of a nail; but the notch or cut in the head is necessary for the peculiar means whereby the screw is worked.

There are five operations here involved—the cutting of the wire to the right length, the forging of the head, the turning of the head and the upper part of the shank, the cutting of the notch, and the cutting of the thread; and these give employment to a large number of persons, chiefly females, at this factory. Several machines of rather intricate construction are used, the result of attempts to combine two or more of the processes in one. In one of these machines a coil of wire, the proper thickness for the screws about to be made, is hung on a kind of handle, and the end of the wire is inserted in a narrow opening; the machine, worked by a steam-engine, is then left to perform its own work: it draws in the wire, cuts off a small piece, presses one end in such a manner as to form the protuberant head of a screw, loosens its hold, and allows the half-made screw to fall into a box beneath. In other machines, nothing is done but cutting off the piece of wire; and each piece, thus cut, is taken up by a boy, who holds it or places it in a separate machine where one end is pressed to form a head.



[Making the Heads of Screws.]

After these preparatory stages, the pieces of wire are handed up to women, who, working at easy ranges of benches, bring the screws to a finished form. One operation is to make the notch in the head of the screw. To effect this, a woman opens with her right hand a kind of clasp or vice attached to the bench, adjusts the screw with her left hand, in such a manner that the head shall be uppermost and elevates the screw by means of a lever till it comes in contact with a small circular disc or cutter, by which a notch or groove is instantly cut in the head of the screw; she then loosens the hold, lets the screw fall into a receptacle, and adjusts another, to be treated in a similar manner.

Another set of workwomen make the thread or spiral cut round the stem of the screw. The screw is attached to a lathe which has a kind of shifting or reciprocating movement given to it; and while the screw is thus rotating and shifting, a woman applies to its surface the end of a sharp-cutting tool, shaped in accordance with the kind of thread required to be cut. The double movement to which the screw is subjected causes the cut to assume a spiral instead of a mere circular form. There is a good deal of tact required in this work, for two or three cutting tools are employed at once, one to give the requisite depth to the

[Cutting the Thread or Worm of Screws.]

cut, and another to impart the proper shape to its sloping sides. The tools have likewise to be constantly wetted with water to prevent them from becoming too rapidly heated; so that the workwomen have many little points to attend to with every screw.

A third set of females are employed in turning the head of the screws in a lathe, to give them a circular and smooth appearance. When all these various processes are finished, the screws are cleansed and brightened by being washed in alkaline water, and then dried.

The cutting of the thread to a screw, like that of the teeth to a file, is a mechanical process which has been made the subject of many attempts at improvement; but it will suffice to have given the general outline of the plan usually followed.

### *Nails.*

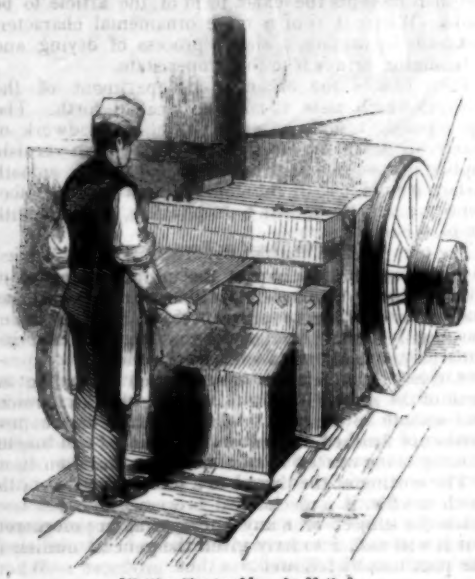
Nails form another curious branch of manufactures in this district; a branch differing from that of wire or of screws in this particular, that it partakes both of the handicraft and of the factory character. Neither wire nor screws can be profitably made without certain mechanical arrangements somewhat beyond the means of a humble workman; but millions of nails are so made.

There is one system adopted in Birmingham, and another adopted in numerous country towns and villages distant a few miles from it. In the factory arrangement in the town itself, the nails produced are generally such as are termed *cut* nails; while in the villages the kind known as *wrought* nails are made. In the former system the nails are made from sheets

of iron; in the latter they are made from small quadrangular rods. In the former a steam-engine is required to drive the machines which make the nails; in the latter the lusty arm of the workman is the only machine. The general system followed by the village 'nailers' was described in No. 606; and it will therefore suffice now to notice the factory arrangements for *cut* nails.

In the north-east part of Birmingham there is a large factory, known as the "Britannia Works," where an entire range of extensive buildings is wholly devoted to this purpose. These stories or ranges of rooms, one over another, are filled with nail-making machines, nearly a hundred in number, all of complicated construction, and all set in motion by one steam-engine. So large and so busy do the arrangements appear, and so stunning the noise produced by all these machines, that it is difficult to bring the mind to think that the whole object in view is nothing more than the making of mere nails. But this is one of the points where *numbers* give importance, irrespective of everything else.

The general principle involved in the manufacture, is to cut up large sheets of iron into strips, and to cut up these strips into nails; subject to a few variations afterwards to be noticed. The iron is brought to the form of sheets at the rolling-mills, in the usual way. When about to be cut into strips, a man takes up one of the sheets, and holds it horizontally in or against a machine in such a manner that a descending blade in-

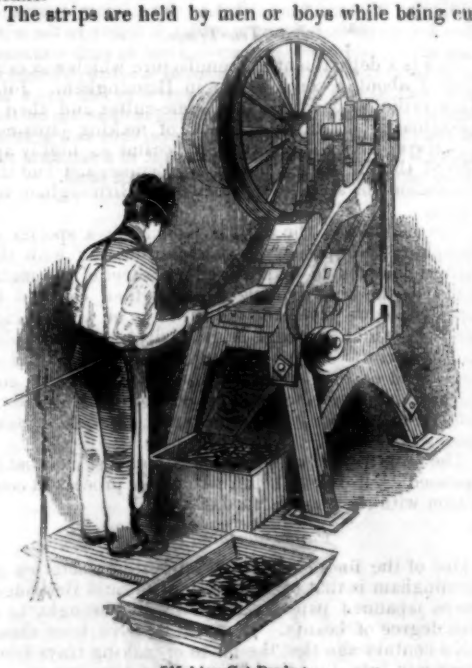


[Cutting Sheets of Iron for Nails.]

stantly severs a strip from it, the width of which is equal to the intended length of the nail. For the largest kinds of nails, this process of cutting the strips requires very forcible means.

When the strips are collected in sufficient quantity, they are cut up into the form of nails, by one or other of three kinds of machines. If we look at a common cut nail, such as those called 'brads,' we shall find that the thickness is equal from end to end, but that the width diminishes so regularly, that if several be arranged alternately with the heads in opposite directions, the whole will form one continuous piece. This is likewise the case whether the nail have a head, or have merely a blunt extremity at the thicker end. Now it is to effect this cutting without any waste that the machines are planned. In one kind of machine, for small brads, the cutter or blade vibrates up and down, cutting off a piece of iron from the strip at each descent; and it has also a swinging motion horizontally, so as to make the cuts at an acute angle with each other. The consequence of this is, that the cuts, being alternately oblique in different directions, give a wedge-shape to the pieces of iron cut off, and these pieces thereupon constitute the nails. In another form of machine the blade has not a swinging movement; but after each cut, the strip of iron is turned over, so as to present the other side uppermost for the next cut; an arrangement which brings about the same wedge-shape to the cut nail, but by different means.

The strips are held by men or boys while being cut,



[Making Cut Brads.]

and are driven onward into the machine as fast as the nails are cut off. In some of the machines, more complicated than the other, the piece of iron, after being cut off from the strip, is caught by a kind of clasp, and exposed to a pressure which gives a head to it, somewhat in the manner of heading screws. A large kind of nail called *spike* nails is made in a different manner, being produced from small quadrangular rods instead of sheets. One end of a rod being inserted in the machine, a piece long enough for a nail is cut off; and this piece is exposed to such powerful pressure as to squeeze it into the form of a nail, the tapering of form being produced neither by cutting nor by percussion. The power required for this is so great, that the rods require to be made red-hot before being cut, to make them more yielding.

All the nails, made by eighty or a hundred machines in this way, are annealed before being fitted for use; and this annealing gives employment to a distinct department of the Works. The nails are put into iron boxes, covered over, and placed in ovens, where they undergo the annealing process. This done, they are emptied into iron barrows, and wheeled to the packing-room, where they are packed in strong hempen bags, or in packages, or in casks, according to their destination.

The packing-room illustrates the vast extent to which the use of cut nails has attained; for it has sometimes contained four hundred tons of iron in the form of nails. When the machines are all in work, they cut up from thirty to forty tons of iron per week; and as there are supposed to be, one taken with another, about a million nails to a ton, this gives forty millions of nails per week, or two thousand millions in a year, as the produce of this one establishment! Supposing these nails to average one inch in length, they would extend more than thirty thousand miles in a straight line, or ten times the distance from England to New York. This is an item in the arithmetic of manufactures which brings the matter home to general readers better than when we speak of tons and hundredweights.

*Iron Tea-Trays.*

This is a department of manufacture which was established about a century ago in Birmingham. John Baskerville, who was first a stone-cutter and then a schoolmaster, introduced the art of making japanned iron trays; and the production became so highly approved that he made a handsome fortune, and laid the foundation for a large department of Birmingham industry.

The making of the trays is principally a species of stamping. Supposing an oblong iron tray with the corners rounded to be required; a sheet of the metal is cut to the required size, and is then exposed to repeated blows from the die or force of a stamping-press, by which the edge is gradually curled up so as to form a rim. The number of blows and the kind of die depend on the depth and pattern of the tray; and after the tray is formed, its flat portion is planished or hammered to give it a closeness and firmness of texture.

The iron trays thus produced are almost invariably japanned; but we can better notice this process in connexion with the manufacture of

*Papier-maché Trays.*

One of the finest and most interesting factories in Birmingham is that of Messrs. Jennens and Bettridge, where japanned papier-maché work is brought to a high degree of beauty. It is said to have been about half a century ago that the mode of making trays from paper was introduced, and from that time successive improvements have been gradually made, both in the paper foundation itself and in the finish given to the surface.

The show-room of the establishment under notice is crowded with specimens, which show how high the art of japanning has now reached. Almost every variety of household furniture, and trinkets without number, are here displayed, exhibiting the intermixture of japanning with painting and with inlaying. This art is independent of the material beneath, for whether this be of iron, wood, or paper, the subsequent processes still continue pretty much the same. The factory, however, embraces the two departments of paper-work and japan-work, and these may be noticed in succession.

There are two modes of manufacturing in paper or 'papier-maché' (literally 'chewed paper,' but implying paper reduced to fragments and softened). In one of these the paper is reduced to a pulpy mass, and pressed into moulds; in the other, sheets of paper are pasted together until the required thickness is attained. It is in this latter mode that tea-trays are made.

In the first place, a cast-iron mould is prepared from a model, the upper surface of the mould corresponding with the interior of the tray to be made. This mould is greased on the surface, and is then prepared to receive its successive garments of paper. The paper employed is a greyish, thick, granulated kind, made for the purpose. It is cut up to the required size and shape by women seated at tables; and the pieces thus cut are handed to the pasters. Every sheet or piece is laid down on a bench, and pasted thoroughly on both sides with a brush. Another woman takes up the pasted sheet, and lays it on the mould, adjusting it to its place; a second piece, similarly pasted on both sides, is laid on the first; and a third on the second. These three thicknesses, are then rubbed and smoothed down well with a cloth, till they follow exactly the contour of the mould; and the mould with its covering is placed in a heated stove-room, where it remains till perfectly dry. Three more thicknesses are applied in a similar way; then a second stove-drying; then three more layers; and so on, until a mass of pasteboard has been produced thick enough for the object in view. An average number of thicknesses is about thirty or forty; but for some purposes there are as many as a hundred and twenty, requiring about forty stove-dryings in the course of the manufacture, and necessarily involving a large amount of manual employment.

When the whole substance is laid on and hardened, the next step is to remove it from the mould or pattern on which it is laid. The edges are cut with a sharp knife, so as to loosen contact at those parts; and as the mould had been greased before the paper was applied, the removal of the latter is easy. When removed, it is trimmed and smoothed by various means, and then presents the exact form of the article to be made. Where it is of a more ornamental character, and made by casting, a simple process of drying and of trimming brings it to the proper state.

Then ensues the ornamental department of the work, in which taste is constantly called forth. The black polished surface, which is the groundwork of nearly all trays, is given by a black japan varnish, applied by women with a brush. A highly smooth surface is produced by rubbing with powdered pumice-stone and afterwards with finer powders, finishing with the bare hand as a rubber.

The painting is a distinct department, and is carried on with much skill. As in most other branches of art, there are manufacturers who serve the cheap as well as those which provide the good; and for threepence or fourpence the centre of a large tray is bedizened with fine staring flowers or ornaments by a process midway between painting and stencilling. But in the kind of work which we have here under notice, the painters are really artists, competent to the production of landscapes, portraits, and other specimens of the pictorial art, the minuteness and high finish of which are made to depend on the costliness of the article produced.

Many highly curious kinds of inlaying are employed in japan-work. Formerly an imitation of tortoise-shell was much in vogue, and was thus produced:—When the tray was properly prepared, a thin transparent varnish was laid on, and leaf silver was laid upon this; the two were hardened together in a stove, and a thick body of varnish was added, capable of concealing the silver; a piece of pumice-stone was applied at spots here and there to remove so much of the varnish as should admit the silver to show slightly through, thereby giving a kind of imitative tortoise-shell appearance. For a commoner sort vermilion was used instead of silver.

Some of the finer kinds of japan-work are inlaid with mother-of-pearl in a curious manner. Pieces of this delicate substance are cut to the exact form required, and laid down upon the wet japan in their proper position; and the whole surface is then varnished and pumiced, varnished and pumiced, so many

times, that the whole comes to a uniform level, and the pearl seems to be inlaid like buhl-work. Another method, for more elaborate patterns, is the following:—The pearl is applied to the surface in a large plain piece, the full size of the device; on this is sketched the exact pattern which the pearl is to present, with a paint which will resist the action of aquafortis; the other parts of the pearl are eaten away by this acid, and thus the required pattern is developed. For commoner kinds of work coloured metallic foil is used instead of pearl, often producing a variegated and pretty appearance. Sometimes japanned articles are gilt all over, previous to the application of these painting or inlaying processes; and by varying the combinations of these methods, there is great scope for the exercise of taste.

Taken altogether, this may be deemed a very pleasing branch of art, and one capable of being applied (if fashion should lead the way) to a number of purposes not yet within its range. The name of 'japan' seems to point to the Eastern origin of this art; and if we refer to the mode of making japanned ware in the Burmese Empire, described in No. 629, we shall see how far there are points of difference in the Eastern and the English modes of procedure. It may be well to state that the distinctive character of japan-work lies in the use of gum and spirit with the colouring agent; instead of oil and turpentine, as in common house-painting and floor-cloth printing; or size and water, as in paper-staining and distemper-painting.

### *Pins.*

"Where do all the pins go to?"—This question has been asked, but it would be somewhat difficult to give a correct answer. Of the millions which are made every year most of them by degrees become 'lost,' and are thought of no more. However, it is lucky for the pin-makers that such is the case; and it may be well here to show briefly how the supply is kept up.

The pin-manufacture is not so much localised as most other branches of manufactures in metal. There are large factories in London, in Birmingham, in Warrington, and in Gloucestershire; and there seems no reason why such should not be the case elsewhere.

This curious and apparently insignificant branch of industry is, like many others, carried on under two different forms; the one by hand labour almost exclusively; and the other wholly, or nearly so, by machinery. The nature of the operations by the hand method gives a more intelligible idea of the object to be attained, than the intricate and complex arrangements of a machine: we will therefore follow the steps of the former.

In the first place the brass wire (for brass it is, however silvery it may look when finished) must be straightened from the coils in which it is brought to the works. This is done by fixing a number of pins in a board, so arranged that if wire be drawn between them it will be forced to assume a straight direction. The wire is cut off into lengths of thirty feet each, and these lengths are further cut into pieces long enough for about half-a-dozen pins. One man used to this employment can straighten twenty thousand dozen of pin-lengths in a day.

Next ensues the pointing. This is effected by applying one end of each wire in the proper position to the edge of a rapidly rotating wheel. A workman takes up twenty or thirty lengths of wire between his fingers and thumbs, ranges them in a row, brings all the ends parallel, and applies the points obliquely to the edge of a steel wheel covered with fine teeth on its surface; he gives a rotatory movement to each wire, by a peculiar action of his fingers, so that in an inconceivably short space of time all the ends are brought to a sharp point; he then applies them to the edge of a rotating gritstone, by which the points become smooth. This operation, like needle-grinding and fork-grinding, is very deleterious, from the particles of metal and of grit which float about in the air; and the same means have been contrived in various quarters to ameliorate the one as the others, subject nevertheless to that strange apathy which too often leads workmen to neglect the most ordinary precautions against disease.

The wires being pointed at both ends, they are cut up into pins. A bundle of them is arranged even and parallel, and a heavy cutting blade is made to sever them all at a particular part of their length, sufficient for one pin; the group is again adjusted, and again cut; and so on until all the pieces have been severed into pin-lengths. The middle pieces, which were not pointed in the original process, are now ranged in order between the fingers and thumbs, and applied to the wheels, where they are all pointed at one end.

Preparations are now made for putting on the 'heads' to the pins. The wire used for this purpose is thinner than that for the shaft of the pin, and is wound into a close spiral round a central wire the same thickness as the pins, by means of a small spinning-wheel. When this coil is finished, it is slipped off the central wire; and six or eight of these being taken up between the fingers of a workman, he cuts them up by means of a fixed chisel or cutter into pieces of either two or three curls each, according to the sort of pin. This operation is one wherein the eye and the fingers of the workman gradually acquire a precision and quickness quite incomprehensible to other persons. A man will cut up eighteen or twenty thousand of these heads in a day, without making a mistake as to the number of curls or turns of the spiral in each head.

When these heads have been annealed, they are fixed on the pins by women and children, a process which has been effected at different times in different ways. By the old method, one of the little coils or heads was taken upon the end of a shank, placed in a small steel die sunk to half the size of the head, and struck by another similar die let fall upon it; by which means the coil became firmly closed upon the pin and formed its head. The falling die was worked by a lever moved by the foot of the workwoman, and the pin was held horizontally. A better mode has been introduced, by which a smooth and more equable head is produced. In this method the pin is placed vertically in a hole, and the upper die falls upon it in such a manner as not only to form and fasten the head, but also to give it a smooth and round surface at the top; and when the heading is done, to obviate the loss of time in moving the pin out of the hole, there is a spring beneath which jerks it up so as to render it easily seized by the fingers. One pin-header can fix from twelve to fifteen thousand in a day.

This being done, the change of colour is wrought. A great quantity of pins is put into a barrel or cylindrical vessel, together with cream of tartar and warm water; and by the rotation of the barrel, and the friction one against another, they become perfectly clean. They are next laid in a copper pan; above them a layer of grain tin, then another layer of pins, and so on alternately till the vessel is full; a little water and cream of tartar are also introduced, and the whole is allowed to boil for an hour. This process is repeated two or three times, by which the surface of the pins become completely coated with a thin layer of metallic tin. The pins are washed in water, separated from the grains of tin by straining, dried in hot bran, and cleansed from the hot bran by winnowing.

Lastly, comes the 'papering,' a process which (rather unnecessarily, it would appear) divides the pins into

pennyworths or smaller quantities. The pieces of paper have grooves or channels impressed on them, by means of a sort of crimping-irons, and the pins being taken up by a kind of comb which places all the points in one direction, are pushed quickly through or into the paper, a small lever being employed to facilitate this process. The children by whom this is done acquire so much expertness in the art, as to be able to paper thirty or forty thousand in a day.

It will thus be seen that the number of distinct operations is very great; and yet so much has the subdivision of labour effected, that three or four thousand pins can be sold for a shilling. It is not at all inconsistent with experience in other subjects that the desire to concentrate the manufacture under mechanical agency should have led to the invention of machines having this object in view. So far back as twenty years ago a machine was patented by which the whole chain of operations was carried on without the aid of manual labour; the wire was drawn off a reel by a pair of pincers, straightened in its passage between a row of pins, cut off to the proper length by a sharp tool, pointed at one wheel and smoothed at another, and lastly headed. Another large establishment, slightly noticed in No. 113, has been devoted to the production of solid-headed pins, in which the head is formed out of a portion of the shank itself, pressed into a globular form.

Ten or a dozen years ago it was stated that twenty millions of pins are required for the consumption of the kingdom *every day!*

### *Steel Pens.*

Steel pens, like pins, are articles so small in size that it is somewhat difficult to bring the mind to estimate them by the ton weight: yet such must be done in viewing them as a branch of manufacture. London has the credit of producing the best pens, or at any rate the highest price is charged for them; but Birmingham is the main seat of the manufacture in respect to quantity. Its manufacturers talk of the millions of dozens which they produce every year; and there can be no doubt, from the large extent of some of the factories, the number made must be enormous.

Every firm has its own peculiar mode of making these little steel implements, differing from that of others in a degree which, though inappreciable by most persons, is important in the eyes of those engaged in the manufacture. Long before the introduction of steel pens as a general article of sale, metallic pens of some kind or other were often made; sometimes silver, when intended for presents; sometimes brass, when intended to accompany cheap brass inkstands that used to be made some years ago. One of the first attempts to combine the elasticity of steel pens with an increased degree of durability, consisted in arming the points with metallic nibs; but the improvement was not adequate to the increased cost. Another class of improvements, or suggested improvements, was the introduction of pens whose nibs should be formed of precious stones, or some other substance of great hardness. One kind, patented twenty years ago, consisted of a tortoiseshell tube or barrel, with small pieces of diamond or ruby imbedded in the nibs. Another kind contained a nib of ruby set in fine gold; and such pens have been said to last six years without injury. A third kind is formed of rhodium nibs set in fine gold. Other varieties have been occasionally brought forward; and at the present day there are small pens to be seen in some of the London shop-windows, marked a guinea each.

But it is the great commercial element of cheapness which gives a character to the manufacture. The millions, and not the units, determine the general arrangements of the whole. A small workshop will suffice for the making of a guinea pen; but a large factory is required for the production of those sold at ten or twenty for a penny. It was not until the general introduction of steel as the material employed, that the matter assumed a commercial importance.

As this manufacture progressed, steel of less and less thickness became employed, so as to give an elasticity as much as possible resembling that of quill pens; and the temper of the steel became an object of especial attention. Whoever has noticed the almost infinite variety in the forms of pens, will perceive that the slits and apertures above the nib are so many contrivances to give elasticity to the pen; and indeed most of the patents have had reference to the arrangement of these incisions.

A description of one of the modes of making common steel pens will illustrate the general character of the manufacture everywhere. A punch is first made of hardened steel, the exact size and shape of the pen to be made. Very fine sheet steel, from the one-hundredth to the two-hundredth of an inch in thickness, is cut up into strips two inches and a half in width; and from these strips small pieces are cut of the proper size for the pens. These blanks are annealed, to remove the hardness which the rolling of the sheets had imparted, and are then well cleansed on the surface. Stamping-presses are then used to impress the maker's name on each blank, and to cut out the aperture, if any. A very fine cutting tool worked by a press is then used to cut the slit in the piece of metal—not entirely through, but leaving it to be finished in an after stage of the operation. The hollow or dished form is given to the blank by placing it on a concave die, and allowing a convex punch to press forcibly upon it, by which it is made to conform to the concavity of the die. The pens thus made are hardened, by being heated and then suddenly cooled; and the slit is finally perfected, or carried entirely through the thickness of the metal, by pinching the nibs in a kind of clasps or pincers.

These are the outlines of the mode employed, subject to variations in different factories. The punching-press is the chief working agent, for by its aid the cutting out of the blank, the lettering and stamping, the forming of the aperture and slit, the dishing, and other parts of the process are done. There is a curious means employed for cleaning the pens when finished or nearly finished. There is a machine employed consisting of a tin cylinder about a yard in length by eight or nine inches in diameter, having a hole in the middle of its length, furnished with a cover or door: the cylinder is hung on joints at each end to cranks formed one on each of two axles. The door is opened, several thousand pens are put into the cylinder, and the latter is made to revolve in such a manner that it shifts backwards and forwards, up and down, so as to shake the pens among each other completely, thereby cleaning them by their mutual friction.

### *Swords.*

It may seem strange that while Sheffield is the head-quarters of the cutlery trade generally, Birmingham should have been the chief seat of the sword-manufacture in this country; yet such seems to be the fact. Perhaps it may be explained from this circumstance, that as Birmingham supplies during war-time an immense number of muskets for the use of the army, an extension of the same agency brought the sword-trade also within reach of the town.

The sword-trade of many different countries has been an object of great importance and solicitude. The possession of a good sword, especially in times and in countries where the arts of war are more cherished than those of peace, is deemed a matter of high import:

and hence the art of the maker has been exercised to find the best mode of imparting the requisite character to these instruments of destruction. Spain was at one time especially famous for her manufacture of swords: the "Toledo blade" being mentioned with high commendation in many a history and romance. On the right bank of the Tagus, not far from the city of Toledo, is still existing a royal sword-manufactory, of which the author of 'A Year in Spain' thus speaks:—"Here are made all the swords, halberds, and lances required for the royal armies. The establishment is on an admirable footing, and the weapons now made in it are said to be nowise inferior to those famous *Toledanos* which, in more chivalrous times, were the indispensable weapons of every well-appointed cavalier. Toledo was not only celebrated in the time of the Moors, but even under the Romans, for the admirable temper of its swords, which is chiefly attributed to some favourable quality in the water of the Tagus used in tempering the steel. As a proof that this is the case, one of the workmen told me that in the earlier period of the French invasion the manufactory was removed to Seville, where the national junta then was; but the swords manufactured on the banks of the Guadalquiver were found to be very inferior to those which the workmen had made in Toledo." If this be really so, and if Toledo blades be better than others, it would seem to be worth while to test this river-water, and see whether a similar quality could be artificially given to the tempering-liquid elsewhere.

Milan was also at one time celebrated for its sword-blades, but Damascus was the most famous place of all. Many are the marvels which have been told of the Damascus blades. There were three cities, Damascus, Cairo, and Ispahan, where highly esteemed swords were made in past times, but where none seem to be made now; so that any at present seen are relics of past times, and are very highly valued. A keenness of edge and a flexibility of substance are the chief characteristics of these blades. Stories have been told of Damascus blades being wound round within a turban, so great was their elasticity; but it is believed that much exaggeration exists in the reputed wonders of these blades. Mr. Holland states that a gentleman who had purchased a Damascus blade in the East Indies for a thousand piastres, told him that although the instrument was very flexible, and bore a very fine keen edge, it could not with safety be bent to more than 45° from the straight shape. The skill and dexterity of the swordsman appear to have had as much to do with the effects produced as the excellence of the sword itself. The Damascus blades are distinguished for a peculiar variegated pattern on the surface, the opinions concerning the mode of producing which are noticed in No. 451.

In respect to the English manufacture, M'Pherson states that on the breaking out of King William's war against France, a company of sword-cutlers was formed for making sword-blades in the county of Cumberland and the adjacent districts; but though they were enabled to purchase lands to erect mills, and to receive and employ great numbers of German artificers, yet they did not succeed. They sold their patent to a company of merchants in London, who thereupon purchased under that patent to the value of 20,000*l.* per annum of the forfeited estates in Ireland. The Irish parliament, however, knowing this estate to have been purchased at a very low rate, would not permit the company in its corporate capacity to take conveyance of lands, lest they might have proved too powerful a body in that kingdom. This obliged them to sell-off their Irish estates, which put an end to the corporation.

It is not very clearly known at what time Birmingham became the centre of the sword-trade, but the manufacture has for many years been one of importance at that place. It is conducted in the following manner:—The steel is brought to the form of what are called *sword-moulds*, either at Sheffield or at Birmingham, these sword-moulds being bars fitted in size and shape for swords. The bars are heated and are forged into shape by two men, the 'maker' and the 'striker,' much in the same way as cutlery. When the sword is required to be hollowed at the surfaces, it is hammered between steel bosses or swages. Then ensue the processes of hardening and tempering, on which so much of the excellence of the sword depends, the hardening being effected by a sudden cooling after heating, and the tempering by a gradual cooling. As the blade has become somewhat distorted in form by these processes, it is twisted straight and regular by confining it at certain points, and forcibly bending it in the proper direction. The whole surface is then ground upon a large stone, and an edge given to it. As it loses some of its temper by this process, it is again tempered and afterwards polished. The making of the handles is a separate department of the manufacture, depending for its character on the costliness of the materials employed.

An important stage in the manufacture of every sword is the 'proof' to which it is subjected, a proof consisting of a series of tests much more violent than the sword is likely ever to undergo in practice. Mr. Inglis, while speaking of the Toledo blades, says:—"The flexibility and excellent temper of the blades are surprising. There are two trials which every blade must undergo before it is pronounced sound, the trial of flexibility and the trial of temper. In the former it is thrust against a plate in the wall, and bent into an arc at least three parts of a circle; in the second it is struck edgeways upon a leaden table with the whole force which can be given by a powerful man holding it with both hands."

In the English method, for a stout cavalry sabre, its point is placed against a pin in a board, and bent round a curve formed by six or eight other pins placed equidistant in the board, the degree of flexure being such that the middle of the sword deviates six or seven inches from a straight line drawn from heel to point. It is then pressed down with its point on a board, and bent round or back to a prescribed distance. It is lastly struck, with all the force a man can use, against a stout wooden block, the edge, the back, and both sides being struck in succession. When the sword has borne all these severe tests, it is declared fit for service, to cut and chop our fellow-men on the field of battle.

## END OF VOLUME THE THIRTEENTH.

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